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SECTION 400

ASPHALT CONCRETE PAVEMENT

401 DESCRIPTION

Asphalt concrete pavement shall consist of asphalt cement uniformly mixed with well graded aggregate and laid upon a prepared surface, along the lines and to the thickness as shown on the approved plans.

402 MATERIAL

402.01 Asphalt Cement

The asphalt cement for the pavement mixture shall be AC-10 or AC-20 and shall conform to the requirements of AASHTO M-226 (latest revision). The asphalt cement shall be homogeneous, free from water, and show no tendency to foam when heated to three hundred forty seven degrees (347°) Fahrenheit. The spot test shall be negative for all grades when conducted with a naphthaxylene solvent containing not more than 10% xylene by volume.

Asphalt cement shall not be heated during the process of its manufacture, storage or during construction, to a temperature so as to cause the formation of carbonized particles. At no time shall the temperature of the asphalt cement be raised above three hundred seventy five degrees (375°) Fahrenheit after loading in a tank for transportation from the refinery to the purchaser.

Written certification of compliance with these specifications shall be given to the Engineer, if requested. The Engineer may, in the absence of written certification, require that samples of the asphalt cement be delivered to an approved testing laboratory to ensure compliance with these specifications.

402.02 Aggregate

The coarse and fine aggregates for the asphalt concrete mixture shall be graded and combined in such proportions that the resulting composite blend meets the grading requirements of the job mix formula. The following gradation table is for identification of material for bidding purposes only.

Sieve Size	Grading C % Passing	Grading CX % Passing
3/4"	100	--
1/2"	70 - 95	100
3/8"	60 - 88	74 - 95
No. 4	44 - 72	50 - 78
No. 8	30 - 58	32 - 60
No. 30	12 - 34	12 - 34
No. 200	3 - 9	3 - 9

Coarse aggregate (material retained on the No. 8 sieve) shall have a "Los Angeles Abrasion Test" (AASHTO T-96) percentage of wear not exceeding (40%). Fine aggregate (material passing the No. 8 sieve) shall have a maximum loss of 12% at five (5) cycles in a sodium sulfate solution by the "Soundness of Aggregate Test" (AASHTO T-104). The aggregate shall be free from clay balls, organic matter, or other deleterious substances. At least seventy percent of the aggregate retained on the No. 4 sieve shall have at least two (2) fractured faces.

402.03 Asphalt-Aggregate Mixture (Job Mix Formula)

The Contractor shall furnish to the Engineer, a mix design from an approved independent testing laboratory, of the proposed asphalt concrete. This job mix formula shall establish a single percentage of aggregate passing each required sieve size, a single percentage of bituminous material to be added to the aggregate, and a single temperature for the mixture at the discharge point of the plant. The job mix formula shall be determined a minimum of once per year, or when the asphalt supplier or aggregate characteristics change. **After the job mix formula has been established, all mixtures furnished for respective projects shall conform thereto within the following ranges of tolerances:**

Maximum Size.....±0%
 Passing No. 8 and larger sieves.....±8%
 No. 8 to No. 200±6%
 Passing No. 200 sieve±3%
 Asphalt Content.....±0.5%
 Discharge Mix Temperature±20°F

TESTING FOR STABILITY		
Test	Marshall (50 blows) AASHTO T-245	Hveem AASHTO T-246
Stability/Stabilometer	2000 lbs. min.	37 min.
Swell	--	0.030 in. max.
Flow, 0.01 "	8 min. - 18 max.	--
Air Voids, Total Mix, %	3% min. - 6% max.	
Index of Retained Strength	80% min. (AASHTO T-165, T-167)	
VMA, (Gradings C)	14 min.	
VMA, (Gradings CX)	15 min.	
Minimum Asphalt Content	5.75% by weight of mixture	

When using the Hveem Mix Design Method, the optimum asphalt content (percent by weight of total mix) is determined from stability values, percent air voids, and observations of surface flushing or bleeding of specimens after compaction. The optimum asphalt content for the mix design should not exhibit moderate or heavy surface flushing, and should be the highest percentage the mix will accommodate without reducing stability or void content below minimum values.

When using the Marshall Mix Design Method, the optimum asphalt content (percent by weight of total mix) is determined as the numerical average of values which yields the maximum stability, maximum unit weight, and median of limits given for percent air voids.

402.04 Quality Control

All samples and tests described herein shall be made in accordance with approved ASTM/AASHTO procedures. The City shall provide for all testing laboratory services in connection with tests verifying conformance of proposed materials with project requirements. The City shall also provide for testing laboratory services in connection with tests on materials after incorporation into the project, on a first time basis only. The costs of any retesting, as required, shall be borne by the Contractor.

Minimum Project Testing:

1. Gradation 1/1000 Tons or 1/project site.
2. Asphalt Content 1/1000 Tons or 1/project site.
3. In-Place Density 1/1000 Tons or min. 1/500 L.F. of paving.
 (including cores & comparative Lab densities)

403 MIXING PLANT

The requirements of this section shall be the same as Section 401.08 "Bituminous Mixing Plant" of the Standard Specifications for Road and Bridge Construction, by the Colorado Department of Transportation, 1991 edition, or as amended. For plant inspection, the Engineer or approved laboratory shall have full right to enter at any time and conduct necessary tests to insure compliance with these specifications.

404 CONSTRUCTION METHODS

404.01 Hauling Equipment

Trucks used for hauling the asphalt concrete mixture shall be equipped with tight, clean, smooth metal beds. When directed by the Engineer, the beds shall be coated with an oil or other approved material to prevent the mixture from adhering to the beds, also each load shall be covered with canvas or other suitable material of sufficient size to protect it from inclement weather conditions.

404.02 Paving Machines

Unless otherwise permitted by the Engineer, the mixture shall be spread by means of a self-propelled laydown machine equipped with a screed or strike-off assembly and capable of spreading and finishing the asphalt concrete mixture to the line, grade, and crown as shown on the plans.

The paver shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed. The mixture shall be dumped in the center of the hoppers, and care exercised to avoid overloading and spilling over of the mixture onto the base.

The screed or strike-off assembly shall effectively produce finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

When laying mixtures, the paver shall be capable of being operated at the necessary forward speeds for satisfactory placement. The operation of the paver shall be such to attain continuous paving.

404.03 Rollers

Rollers shall be steel wheeled and/or pneumatic tire type and be in good condition, capable of reversing without backlash. They shall weigh not less than eight (8) tons. All rollers shall have a water system capable of keeping the wheels properly moistened to prevent adhesion of the mixture to the wheels.

404.04 Paving Surface

After the pavement base has been prepared, it shall be made ready for paving by clearing any loose material off as directed by the Engineer, and applying a prime coat as specified in Section 411 of these specifications. The rate of application of the prime coat shall be 0.3 gallons per square yard, or as directed by the Engineer. Edges of all contact surfaces such as curb and gutter, manholes, cross pans and other structures shall be coated with the prime coat material as described herein before paving. When more than one lift is required, a tack coat shall be used between courses of pavement in accordance with Section 412 of these specifications at the rate of 0.1 gallons per square yard, or as directed by the Engineer.

Asphalt concrete pavement shall be a minimum of two (2) inches compacted thickness and shall be laid in one (1) lift. If a thickness greater than three (3) inches is specified, separate courses shall be laid; each course shall be not less than one (1) inch compacted thickness, nor greater than three (3) inches compacted thickness.

404.05 Spreading, Finishing, and Compaction

The mixture shall be laid upon the approved base surface, spread, and struck off to the grade and elevation required. Pavers shall be used to distribute the mixture over the entire surface except where hand placing is necessary.

The longitudinal and transverse joints shall be made in a careful manner, well bonded and sealed. If directed, the joints shall be coated with tack coat material.

On the areas where the use of mechanical pavers cannot be used, the mixture shall be spread, raked and luted by hand tools. When material is shoveled, it shall be deposited by turning the shovel over above the desired area. No "slinging" of the shovel will be permitted. The hand placed material shall be smoothed and left higher than the machine laid material by about 1/4 inch per inch of depth prior to rolling. If the machine laid mixture has been rolled, then the hand laid mixture shall be smoothed and left higher than the rolled pavement by about 1/4 inch per inch depth. The majority of the raker's work shall be done with a lute rather than a tined rake.

Segregation of materials shall not be permitted. If segregation occurs, the spreading operation shall be immediately suspended until the cause is determined and corrected.

Placing the mixture shall be as continuous as possible. All surface irregularities shall be adjusted by the addition or removal of mixture prior to rolling. After the mixture has been spread, struck off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling.

The surface shall be rolled at a specified breakdown temperature which shall be determined by the Contractor's foreman and the Engineer at the beginning of the job. The breakdown temperature shall be such that the required density is obtained without displacement, cracking, or shoving of the mixture. The rollers shall operate at a speed slow enough to avoid displacements or "crawl" of the mixture. Any displacement shall be immediately corrected by means suitable to the Engineer.

The number, weight, and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. The minimum number of rollers shall be two. Heavy equipment or rollers shall not be allowed to stand on freshly placed pavement.

Unless otherwise directed, rolling shall begin at the sides and proceed longitudinally parallel to the street centerline, each pass overlapping one-half the roller width, gradually progressing to the crown of the street. When paving adjacent to a previously placed lane, the longitudinal joint shall be rolled first followed by the regular rolling procedure.

Rolling shall be continued until all roller marks are eliminated and no further compression is possible. The minimum density of the compacted mixture shall be 95% of the maximum density required to provide laboratory compacted specimen made in the same proportions as the job mix formula (AASHTO T-209). However, if in the opinion of the Engineer a 95% density would prove to be detrimental to the asphalt cement pavement, then a density of 93% will be allowed. Along forms, curbs, manholes, and other places not accessible to rollers, the mixture shall be thoroughly compacted with hand tampers or with mechanical tampers. The joints between these structures shall be effectively sealed.

Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh hot mixture, which shall be compacted to conform with the surrounding area.

404.06 Joints

Transverse joints shall be formed by cutting through the previously laid course to expose the full depth of the course. A coat of tack coat material shall be used on contact surfaces of all joints just before additional mixture is placed.

404.07 Weather Limitations

The placing and compacting of asphalt surfacing shall be performed only when weather conditions are suitable. Asphalt surfacing shall not be placed on surfaces which are damp or wet nor when the temperature of the surface on which the asphalt pavement is to be placed is less than 40 degrees Fahrenheit and the atmospheric temperature is less than 40 degrees Fahrenheit. The temperature of the mixture delivered to the jobsite shall not be less than 225 degrees Fahrenheit. When the atmospheric temperature is less than 50 degrees Fahrenheit, all loads shall be delivered continuously in covered vehicles.

404.08 Surface and Thickness Tolerances

The surface of the finished pavement shall be free from depressions exceeding 3/16 inch in 10 feet, when tested with a straight-edge. All depressions exceeding the specified tolerances shall be corrected by removing defective work and replacing it with new material as directed. The surface shall be smooth and true to the established crown and grade. The required compacted thickness shall be as specified on the construction drawings.

405 RESTRICTION OF TRAFFIC

The Contractor shall arrange the work in such a manner as to cause a minimum of inconvenience to the traveling public and the abutting property owners. The Contractor shall submit to the Engineer a plan of this operation. In general, the Contractor shall be allowed to proceed as he proposes. However, the Engineer retains the authority to order the Contractor to schedule the proposed operation in another manner if such a change in schedule is to the benefit of the owner and beneficial to the interests of a good project. The Contractor shall arrange to have the haul vehicles operate over roads which will not be damaged by such vehicles. The Contractor shall provide all necessary Traffic Control in conformity with these provisions and specifications and with the ordinances and regulations of the City of Colorado Springs, in particular to Section 22-1-315 of the City Code, "Work Zone Traffic Control". Traffic Control shall be paid for as specified in the contract documents.

406 PATCHING

Remove the backfill material to the depth and extent required in accordance with drawing nos. D-3, D-4, or D-5, whichever applies. Prepare the subsurface with the required base course and/or Portland Cement concrete subsurface in accordance with the above referenced drawings and as specified in Section 200 and 300 of the City of Colorado Springs Standard Specifications. Depths and/or thickness of base course, Portland Cement concrete and/or asphalt pavement shall be as indicated on the drawings. The asphalt pavement shall be a minimum of four (4) inches or equal to the existing pavement

thickness, whichever is greater. The backfill and base coarse material shall be thoroughly compacted to the densities specified in Section 205 and 303 with a roller for large areas and smaller hand operated compactor for small patches.

Existing pavement may be rough cut initially in conjunction with trenching; however, a square even vertical cut shall be made in the existing asphalt cement pavement after placement of backfill and prior to pavement replacement. The square vertical cut shall be made at a minimum of six (6) inches back from the trench line into good pavement. Before placement of the new pavement, the cut edges shall be thoroughly cleaned and a tack coat shall be uniformly and evenly applied to vertical faces in accordance with Section 412. The patch shall be made with placement of a hot asphalt cement and

aggregate mixture as described in Section 401 of the Standard Specifications for Road and Bridge Construction, latest edition, by the Colorado Department of Transportation.

In large patches or whenever possible, a self-propelled paving machine shall be used to place the mixture. In small patches, the material shall be hand placed or placed with a spreader box without separation of the mixture. The material shall be placed to the grade and thickness required to allow for compaction after rolling. The hot mix material shall be compacted using the number, weight and type of rollers required to provide 95% of the maximum density of a laboratory compacted specimen made in the same proportions as the job mix formula (AASHTO T-209). Rolling shall continue until all roller marks are eliminated and no further compression is possible in the pavement. After rolling the surface, a straight-edge or a stringline shall be used to check grade and riding quality of the patch.

407 RECYCLED PLANT MIX BITUMINOUS PAVEMENTS

Plant mixed bituminous pavements shall not contain more than 20% reclaimed asphalt pavement. The reclaimed asphalt pavement shall meet all the requirements for hot bituminous pavement, as contained herein.

- A. Reclaimed Asphalt Pavement (RAP) Material: The Engineer may require the contractor to maintain separate stockpiles for each type of RAP material. All processed material shall be free of foreign materials and segregation shall be minimized. The RAP material shall be processed, if needed, so that at least 95% passes through a 5/8 inch sieve. Any RAP material that cannot be readily broken down in the mixing process and/or affects the paving operation, shall be processed prior to mixing with the virgin material.
- B. Composition of Mixtures: Tests for cleanliness, abrasion loss, and percent of fractured faces will be made on representative samples of aggregate taken during production or from the stockpiles. Proportions of the reclaimed and virgin material shall be determined and proposed by the Contractor to

meet the mix composition requirements of this Section No. 400 of the Standard Specifications. The maximum aggregate size contained in the combination of reclaimed asphalt pavement and new aggregate shall not exceed the maximum specified in the gradations presented in Section 402 of these specifications.

1. Job-Mix Formula: See Section 402.03 of these specifications for approval of mix design. Cost for this testing shall be the responsibility of the Contractor.
2. Uniformity: After the job-mix formula has been approved, the owner shall implement an acceptable quality control plan as detailed in Section 406 of these specifications. Deviations from the final approved design for bitumen content and gradation of aggregates shall not be greater than the tolerances listed in Section 402 of these specifications and shall be based on the extraction test.
3. Bituminous Mixing Plant:
 - a. Batch Plant - The batch plant shall be modified to allow weighing the reclaimed asphalt pavement (RAP) material prior to incorporation into the pugmill. The cold feed bin, conveyor system and the special bin adjacent to the weigh box, if used, shall be designed to avoid segregation and stocking of the RAP material. The virgin aggregates shall be dried and heated to a suitable temperature so that on combining with the RAP material at ambient temperature the resulting mix temperature of successive loads may be a cause for a rejection of the mix by the Engineer. The virgin aggregates shall be free of unburned fuel oil when delivered to the pugmill.
 - b. Drum Mixer Plant - The drum mixer plant shall be modified to prevent direct contact of the RAP material with the burner flame and/or overheating of the RAP material in the process.

408 MEASUREMENT AND PAYMENT

Asphalt concrete pavement courses measured by the square yard, will be paid for at the contract unit price per square yard. This payment shall be full compensation for all materials, tools, equipment, and labor necessary to complete the work under this section in accordance with the plans and these specifications. The payment shall be full compensation for prime and/or tack coats applied in accordance with these specifications.

If there is no pay item for asphalt concrete pavement of the type specified it will not be measured and paid for separately but shall be included in the pay item most closely associated with the work. Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Asphalt Concrete Pavement (Grading) (Asphalt)	S.Y.
Asphalt Concrete Pavement (RAP) (Asphalt)	S.Y.
Asphalt Concrete Pavement (Patching) (Asphalt)	S.Y.

SECTION 410 ASPHALTIC PRIME COAT AND TACK COAT

411 PRIME COAT

411.01 Description

When indicated in Bid Proposal or the plans, all prepared or existing surfaces ready for asphaltic surfacing shall be primed with a cut-back asphaltic oil in accordance with these specifications, or as directed by the Engineer.

411.02 Surface Preparation

Before applying the prime coat, all loose material shall be removed from the surface as directed by the Engineer. That portion of the surface prepared for treatment shall be dry and in satisfactory condition.

411.03 Liquid Asphalt

The cut-back liquid asphalt shall be MC-70 and shall satisfy the requirements of ASTM 2027. MC-250 may be used under certain conditions with written permission from the Engineer.

411.04 Placing

The prime coat shall be placed by means of an approved pressure distributor capable of applying the prime coat uniformly to the surface to be treated in the required quantity and maintain the specified rate of the entire load regardless of changes in grade. Before application, the liquid asphalt shall be heated to the proper viscosity for spraying, however, the temperature shall not exceed 130 degrees Fahrenheit. The rate of application shall be 0.3 gallons per square yard or as directed by the Engineer. The prime coat shall not be applied when the surface is wet or when the atmospheric temperature is less than 40 degrees Fahrenheit, or when precipitation is imminent.

The prime coat shall be carefully applied. If excessive amounts of curb, sidewalks, or other structures are sprayed with liquid asphalt, they shall be cleaned as directed by the Engineer at the Contractor's expense. The prime coat shall be allowed to cure for a minimum of 24 hours prior to the paving operation. If after the curing period, the prime coat has not penetrated the base materials, and the surface must be used by traffic, a suitable blotter material shall be applied in amounts needed to absorb excess liquid asphalt. The blotter material shall be a dry, gritty sand.

412 TACK COAT

412.01 Description

Existing asphalt surfaces receiving an asphalt overlay, existing vertical concrete surfaces such as curb and gutter, crosspans and manholes, or the first course of multi-course asphaltic pavement structure, shall receive a tack coat consisting of an emulsified asphalt in accordance with these specifications at the locations shown on the plans, or as directed by the Engineer.

412.02 Surface Preparation

Before applying the tack coat, surfaces shall be thoroughly cleaned of all dirt and other debris to insure adequate bond between tack surface and asphaltic mat.

412.03 Liquid Asphalt

The liquid asphalt used for tack coat shall be an emulsified asphalt grade CSS-1h or SS-1h and shall satisfy the requirements of ASTM 977. Other emulsified asphalts may be used upon written permission of the Engineer.

412.04 Placing

Refer to Section 411.04. The rate of applications shall be 0.1 gallons per square yard and provide a uniform and even coating of the surface. The surface shall be allowed to cure to permit drying and setting of the tack coat prior to the paving operation.

413 MEASUREMENT AND PAYMENT

Payment for prime coat and/or tack coat shall be included in the unit price bid for asphaltic concrete pavement, Section 400, and shall include all materials, tools, equipment, and labor necessary to complete the work in accordance with the plans and specifications, and as directed by the Engineer.

SECTION 420 ASPHALTIC OVERLAY (PLANT MIX SEAL)

421 DESCRIPTION

The work to be performed under this section shall consist of the construction of an asphalt plant mix overlay where required by the Engineer.

422 MATERIALS

422.01 Asphalt Cement

The asphalt cement for the pavement mixture shall be AC-20 and shall conform to the requirements of AASHTO M-226, or as revised. AC-10 may be used only under authorization of the City Engineer. The asphalt cement content shall be 6% to 7% by weight of the mixture, dependent upon the requirements of the job mix formula. The asphalt cement shall be homogenous, free from water and show no tendency to foam when heated to three hundred forty-seven degrees (347) Fahrenheit. The spot test shall be negative for all grades when conducted with a naphthaxylene solvent containing not more than 10% xylene by volume.

Asphalt cement shall not be heated during the process of its manufacture, storage or during construction to a temperature so as to cause the formation of carbonized particles. At no time shall the temperature in storage be more than 10 degrees Fahrenheit below the actual flashpoint of the asphalt cement, nor shall the temperature of the asphalt cement be raised above 375 degrees Fahrenheit after loading in a tank for transportation from the refinery to the purchaser.

Written certification of compliance with these specifications shall be given to the Engineer, if requested. The Engineer may, in the absence of written certification, require that samples of the asphalt cement be delivered to an approved testing laboratory for testing to ensure compliance with these specifications.

422.02 Aggregate

The coarse and fine aggregates for the mixture shall be graded and combined in such proportions that the resulting composite blend meets the grading requirements of the job mix formula. The following gradation table is for identification of material for bidding purposes only.

Sieve Designation	Gradation B % Passing
1/2"	100
3/8"	90-100
No. 4	40-60
No. 8	20-47
No. 50	4-18
No. 200	2-9

Coarse aggregate (Material retained on the No. 8 sieve) shall have not more than 40% wear per the "Los Angeles Abrasion Test". Fine aggregate (Material passing the No. 8 sieve) shall have a maximum loss of 12% at 5 cycles in a sodium sulfate solution by the "Soundness of Aggregates Test".

The aggregate shall be free from vegetable matter, clay, and deleterious substance.

All of the particles retained on the No. 4 sieve shall have at least two fractured faces.

Mineral filler shall conform to the requirements of ASTM D-242.

422.03 Asphalt-Aggregate Mixture

(Job Mix Formula.) The Contractor shall furnish to the Engineer a mix design from an approved testing laboratory of the asphaltic concrete he proposes to use. The job mix formula shall be within the range as shown in the table above with allowable tolerances.

Marshall Stability	2000 Min.
Marshall Flow (1 /100th inch)	8 Min. - 18 Max.
Swell (Hveem), inches	0.03 Max.
Percent Air Voids	3 Min. - 6 Max.
Percent Voids filled with Bitumen	75-85
Wet/Dry Stability Ratio	80 Min.

Tolerances for the job mix formula shall be as follows:

Aggregate Passing No. 4 and larger sieves	±7%
Aggregate Passing No. 8 thru No. 100 sieves	±5%
Aggregate Passing No. 200 sieve	±3%
Asphalt Cement	±0.3%

422.04 Testing

All samples and tests shall be made in accordance with approved ASTM procedures. All costs of providing samples and tests herein are the responsibility of the Contractor.

423 MIXING PLANT

The requirements of this section shall be the same as Section 401.08, "Bituminous Mixing Plant", of the Standard Specifications for Road and Bridge Construction, by the Colorado Department of Transportation, latest edition. For plant inspection, the Engineer or approved laboratory shall have full right to enter at any time and conduct necessary tests to insure compliance with these specifications.

424 MATERIAL PREPARATION AND MIXING

The asphalt cement shall be heated at the paving plant to a temperature at which it can be applied uniformly to the aggregate.

The aggregates shall be dried and heated to the required temperature. Immediately after heating and drying, the aggregates shall be screened and stored in two or more bins ready for mixing with asphalt cement.

The dried aggregates shall be combined in the mixer in the amounts necessary to satisfy the job mix formula. The asphalt cement shall be measured and introduced into the mixer in an amount specified by the job mix formula.

The asphalt cement and the aggregate shall be introduced into the mixer within 35 degrees Fahrenheit of each other. The mixing temperature shall be greater than 225 degrees Fahrenheit and less than 325 degrees Fahrenheit. The temperature of the mixture delivered to the paving machine shall not be less than 225 degrees Fahrenheit.

After the required amounts of asphalt cement and aggregate have been introduced into the mixer, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the asphalt cement throughout the aggregate is secured. Mixing times shall be established by the "Ross Count Procedure " as contained in ASTM D-2489.

425 CONSTRUCTION METHODS

425.01 Hauling Equipment

Trucks used for hauling the asphaltic concrete mixture shall be equipped with tight, clean, smooth metal beds. When directed by the Engineer, the beds shall be coated with an oil or other approved material to prevent the mixture from adhering to the beds, also each load shall be covered with canvas or other suitable material of sufficient size to protect it from weather conditions.

425.02 Paving Machines

Unless otherwise permitted by the Engineer, the mixture shall be spread by means of a self-propelled paver, with an activated screed or strike-off assembly and capable of spreading and finishing the asphaltic concrete mixture to the line, grade, and crown as shown on the plans.

The paver shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The hopper shall be equipped with a distributing system to place the mixture uniformly in front of the screed. The mixture shall be dumped in the center of the hoppers, and care exercised to avoid overloading and spilling over of the mixture onto the base.

The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

When laying mixtures, the paver shall be capable of being operated at the necessary forward speeds for satisfactory placement. The operation of the paver shall be such to attain continuous paving.

425.03 Rollers

Rollers shall be steel wheeled and pneumatic tire type and be in good condition, capable of reversing without backlash. They shall weigh not less than eight (8) tons. All rollers shall have a water system capable of keeping the wheels properly moistened to prevent adhesion of the mixture to the wheels.

425.04 Paving Surface

The pavement shall be clean and dry prior to overlay, and all sweeping shall be accomplished by the Contractor. The Contractor shall keep all sweepings off public sidewalks, parking strips, and private lawns.

The clean street surface shall receive a tack coat as specified in Section 410.

The thickness of overlay shall be as specified and shall not be less than 1/2" compacted thickness.

425.05 Spreading, Finishing, and Compaction

The mixture shall be laid upon the approved base surface, spread, and struck off to the grade and elevation required. Pavers shall be used to distribute the mixture over the entire surface except where hand placing is necessary. The maximum paving width shall be twelve feet (12'). Street crowns shall be transitioned to straight cross slope at intersections to match the existing surface. The longitudinal and transverse joints shall be made in a careful manner, well bonded and sealed. If directed, the joints shall be coated with tack coat material.

On the areas where the use of mechanical pavers cannot be used such as at curb returns and catch basins, the mixture shall be spread, raked and luted by hand tools. When material is shoveled, it shall be deposited by turning the shovel over above the desired area. No "slinging" of the shovel will be permitted. The hand placed material shall be smoothed and left higher than the machine laid material by about 1/4 inch per inch depth. The majority of the raker's work shall be done with a lute rather than a tined rake.

Segregation of materials shall not be permitted. If segregation occurs, the spreading operation shall be immediately suspended until the cause is determined and corrected.

Placing the mixture shall be as continuous as possible. All surface irregularities shall be adjusted by the addition or removal of mixture prior to rolling. After the mixture has been spread, struck off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling.

The mixture shall be struck off square at the end of the overlay section.

The Contractor shall use a steel wheeled roller for breakdown rolling, a pneumatic tire roller for intermediate rolling, and a steel wheeled roller for finish rolling.

The surface shall be rolled at a specified breakdown temperature which shall be determined by the Contractor's foreman and the Engineer or Inspector at the beginning of the job. The breakdown temperature shall be such that the required density is obtained without displacement, cracking, or shoving of the mixture.

The rollers shall operate at a speed slow enough to avoid displacements or "crawl" of the mixture. Any displacement shall be immediately corrected by means suitable to the Engineer.

The number, weight, and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. Heavy equipment or rollers shall not be allowed to stand on freshly placed pavement.

Unless otherwise directed, rolling shall begin at the sides and proceed longitudinally parallel to the street centerline, each pass overlapping one-half the roller width, gradually progressing to the crown of the street. When paving adjacent to a previously placed lane, the longitudinal joint shall be rolled first, followed by the regular rolling procedure.

The amount of rolling shall be confined to only that necessary for consolidating the seal coat and bonding it to the underlying surface course. Excessive rolling shall be avoided.

Along forms, curbs, manholes, and other places not accessible to rollers, the mixture shall be thoroughly compacted with hand tampers or with mechanical tampers. The joints between these structures shall be effectively sealed.

Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh hot mixture, which shall be compacted to conform with the surrounding area.

425.06 Joints

Transverse joints shall be formed by cutting through the previously laid course to expose the full depth of the course. A coat of tack coat material shall be used on contact surfaces of all joints just before additional mixture is placed.

425.07 Weather Limitations

The placing and compacting of asphaltic surfacing shall be performed only when weather conditions are suitable. Asphaltic surfacing shall not be placed on surfaces which are damp or wet nor when the temperature of the surface on which the asphaltic pavement is to be placed is less than 60 degrees Fahrenheit and the atmospheric temperature is less than 60 degrees Fahrenheit. The temperature of the mixture delivered to the jobsite shall not be less than 225 degrees Fahrenheit.

425.08 Surface and Thickness Tolerances

The surface of the finished pavement shall be free from depressions exceeding 3/16 inch in 10 feet, when tested with a straight-edge. All depressions exceeding the specified tolerances shall be corrected by removing defective work and replacing it with new material as directed.

The surface shall be smooth and true to the established crown and grade.

426 RESTRICTION OF TRAFFIC

The Contractor will arrange his work in such a manner as to cause a minimum of inconvenience to the traveling public and the abutting property owners. The Contractor shall submit to the Engineer a plan of this operation. In general, the Contractor will be allowed to proceed as he proposes. However, the Engineer retains the authority to order the Contractor to schedule his proposed operation in another manner if such a change in schedule is to the benefit of the owner and beneficial to the interests of a good job. Any and all traffic barriers, warning signs, and flagmen which are necessary will be provided by the Contractor. The Contractor will arrange to have his haul vehicles operate over roads which will not be damaged by such vehicles. The Contractor shall provide a minimum of two flagmen.

427 MEASUREMENT AND PAYMENT

Asphaltic overlay measured by the ton will be paid for at the contract unit price per ton as set forth in the Bid Proposal. This payment shall be full compensation for all material, tools, equipment, and labor necessary to complete the work under this section in accordance with the plans and these specifications. The payment shall also be full compensation for the tack coat applied in accordance with these specifications.

SECTION 430 CONCRETE PAVEMENT

431 DESCRIPTION

The work performed under this section shall consist of the construction of a pavement composed of Portland cement concrete, with or without reinforcement as specified, on a prepared subgrade or base course in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established.

432 MATERIAL SPECIFICATIONS

432.01 General

The specifications presented in this section are performance oriented. The City's objective in setting forth these specifications is to achieve an acceptable quality of streets. All sources for the mined or manufactured materials listed in Section 432.05 must be annually approved by the City as having met the appropriate materials performance specifications. This approval is a condition of using those material sources for public improvement construction.

432.02 Procedure For Material Source Approval

On or before April 1st of each year, a material supplier for any City improvement shall supply written documentation and material test results from a qualified, independent materials testing laboratory that describes:

1. Material(s) being tested to meet City specifications.
2. The test procedures employed.
3. The supplier(s) manufacturing, mining or treating process by which the tested materials were created.
4. The material test results.
5. A signed statement by the material supplier that the materials produced and tested for this certification are truly representative of the materials to be provided for public improvements in the City during the coming 365 day period.

432.03 Violations of Approval Conditions

Random Testing. The Engineer may order random tests of materials used in City improvements to verify compliance with the material specifications. These tests are in addition to the requirements of Section 434 of this Chapter.

432.04 Use of Materials Not Listed in Section 432.05

Materials listed in this section and provided with a set of specifications are those deemed by the City to be the primary structural materials commonly or typically used in public improvements. Ancillary public improvement materials such as manufactured paints and coatings, bonding agents, sealers, gaskets, insulating materials, etc. should be in compliance with Colorado Department of Highways material specifications for the appropriate material employed. Alternative materials for construction may be proposed for use. Decisions on acceptability of alternative materials will be made by the Engineer.

432.05 Portland Cement Concrete

This material shall consist of a mixture of fine and coarse aggregates, Portland cement, water and other materials or admixtures as required.

- A. Portland cement shall comply with the Colorado Department of Highways requirements and ASTM C-150, C-175 or C-595. The type of cement shall be Type IIA (air entraining) or Type V, unless sulfate conditions allow otherwise. Table 2.2.3 in Chapter 2.2 of ACI 201 presents cements recommendations for sulfate resistances. In addition to the standard chemical requirements for Portland cement in ASTM C-150, the maximum percent of alkalies shall be as specified in Table 2 of ASTM C-150 for low-alkali cement. Other types of cement or admixtures are only to be used upon approval by the Engineer.
- B. Fine aggregate shall consist of natural sand, manufactured sand, or a combination thereof. Fine aggregate shall meet Colorado Department of Highways Section 703.01 requirements and gradation, except as shown in the Table below.

FINE AGGREGATES FOR PORTLAND CEMENT CONCRETE	
Sieve Size or Test Procedure	Percent Passing or Test Requirement
3/8"	100
No. 4	95-100
No. 16	45-80
No. 50	10-30
No. 100	2-10
No. 200 (AASHTO T-11)	* 3.0 Max.
Clay Lumps & Friable Particles,% (AASHTO T-112)	3.0 Max.
Coal & Lignite, %, (AASHTO T-113)	1.0 Max.
Deleterious Material, %, (AASHTO T-11)	3.0 Max.
Sand Equivalent, %, (AASHTO T-176)	75 Min.
Fineness Modulus	2.50-3.50
Sodium Sulfate Soundness, %, (AASHTO T-104)	10 Max.

* 5.0 Max. for crusher fines

- C. Coarse aggregate shall consist of gravel, crushed gravel, crushed stone, air cooled blast furnace slag, or crushed hydraulic-cement concrete, or a combination thereof, conforming to the requirements of this specification. Coarse aggregate shall meet Colorado Department of Highways Section 703.02 requirements and gradation, except as shown in the Table below.
- D. Fly ash only to be used on a case-by-case basis when approved by the Engineer.
- E. Portland cement will be accepted on the basis of certificates of compliance and ASTM C-150. Reinforcing steel, dowel and tie bars will be accepted by certificate of compliance and mill reports. Water, if not potable, shall be sampled and tested before use. Water shall meet the requirements of Colorado Department of Highways Section 712.01. Only Colorado Department of Highways approved brands of air entraining agents, chemical admixtures and curing materials may be used and must be documented.

- F. Calcium chloride shall not be used as an admixture in concrete. Admixtures used in prestress or bridge deck concrete shall meet the chloride limitations of ACI 201 for total chloride in concrete.
- G. The curing compound shall be a white pigmented liquid membrane forming curing compound and meet the requirements of AASHTO M-148. The curing compound shall be applied under pressure at the rate of one gallon to not more than 150 square feet by mechanical sprayers.

COARSE AGGREGATES FOR PORTLAND CEMENT CONCRETE	
Sieve Size or Test Procedure	Percent Passing or Test Requirement
2"	100
1-1/2"	95-100
3/4"	35-70
3/8"	10-30
No. 4	0-5
No. 200 (AASHTO T-11)	* 1.0 Max.
% Wear (AASHTO T-96)	45 Max.
Clay Lumps & Friable Particles, % (AASHTO T-112)	5.0 Max.
Coal & Lignites, %, (AASHTO T-113)	0.5 Max.
Sum of Clay lumps, Friable Particles and Chert, (AASHTO T-11)	7.0 Max.
Sodium Sulfate Soundness, %, (AASHTO T-104)	12 Max.

* 1.5 Max. for crusher fines

NOTE: AASHTO M-43, Size No. 57 may also be used on a case-by-case basis when approved by the Engineer.

- H. Reinforcing steel shall meet the requirements of Colorado Department of Highways Section 709.01, grade 40 minimum.
- I. Proportioning - Minimum laboratory trial mix strength shall be 600 psi (third point flexural) at age 28 days (ASTM C-78). A minimum of 6 test cylinders shall also be taken of the laboratory mix for future correlations (ASTM C-39).

Cement - 564 lbs. minimum per cubic yard of concrete

Air Content - 6% ($\pm 1\frac{1}{2}\%$)

Slump - 3 inch maximum (may be increased to 4 inches for hand work).

Water/Cement Ratio - 0.45 maximum

433 CONSTRUCTION REQUIREMENTS

Materials shall be proportioned, handled, measured, batched, placed, finished and cured in accordance with Section 412 of the Colorado Department of Highways Specifications and ASTM C-94 (whichever is more stringent).

434 QUALITY CONTROL

All samples and tests described herein shall be made in accordance with approved ASTM/AASHTO procedures. The owner/developer shall provide for all testing laboratory services in connection with tests verifying conformance of proposed materials with project requirements. The owner/developer shall also provide for testing laboratory services in connection with tests on materials after incorporation into the project, on a first time basis only. The costs of any retesting, as required, shall be borne by the Contractor.

During placement of Portland cement concrete pavement, observation and testing shall be on a full-time basis. For each day of production, aggregate samples shall be obtained for gradation of both the coarse and fine aggregates.

Slump, air content, unit weight and mix temperature shall be tested for each set of cylinders taken. The first three loads shall be tested for slump and air content. If any one test fails to meet requirements, that load shall be rejected and tests shall continue on each load until three consecutive loads meet requirements. Thereafter, slump, air content, unit weight and mix temperature shall be tested at least every 100 cubic yards. Any load not meeting test specifications shall be rejected.

Five compressive strength cylinders shall be fabricated for each 100 cubic yards or major fraction thereof on each day pavement is placed. Cylinders shall be tested as follows: 2 at 7 days, 2 at 28 days and 1 at a later date, if necessary, as required by the Engineer.

Thickness of fresh concrete must be checked a minimum of every 300 lineal feet each traffic lane according to the Colorado Department of Highways Section 412.24. Any noted deficiency areas shall be corrected at that time. Surface deficiency areas shall also be corrected at that time. Surface smoothness shall be tested and corrected as necessary according to Colorado Department of Highways Section 412.16. The Engineer will decide when the pavement shall be opened to traffic; otherwise the pavement shall not be opened to traffic until 14 days after the concrete was placed, or until the compressive strength of laboratory cured 6 x 12 cylinders (ASTM C-39) averages 3000 psi. Prior to opening to traffic, the pavement shall also be cleaned and all joints sealed.

435 FINAL ACCEPTANCE

All test results shall be submitted and reviewed by the City. Provided all tests are acceptable, the pavement will be accepted. Should testing indicate unsatisfactory work, removal, replacement, grinding or reduced payment will be required.

436 MEASUREMENT AND PAYMENT

The accepted quantities of concrete pavement will be paid for at the contract unit price per square yard which price and payment shall be full compensation for furnishing and placing all materials, including any dowels, tie bars and joint material, provided, however, that for any pavement found deficient in thickness by more than 0.20 inch, but not more than 1.0 inch, only the reduced price stipulated below shall be paid.

No additional payment over the unit contract bid price will be made for any pavement which has an average thickness in excess of that shown on the plans. Reinforcing steel, other than as mentioned above, will be measured and paid for in accordance with the Colorado Department of Highways Section 602.

Where the average thickness of pavement is deficient in thickness by more than 0.20 inch, but not more than 1.0 inch, payment will be made at an adjusted price as specified in the following table.

CONCRETE PAVEMENT DEFICIENCY	
Deficiency in Thickness (Determined by Cores) INCHES	Proportional Part of Contract Price Allowed
0.00 to 0.20	100%
0.21 to 0.30	80%
0.31 to 0.40	72%
0.41 to 0.50	68%
0.51 to 0.75	57%
0.76 to 1.00	50%
Over 1.00	NONE

When the thickness of pavement is deficient by more than one inch, and judgement of the Engineer is that the area of such deficiency should not be removed and replaced, there will be no payment for the area retained.